

BRIEFER ARTICLES.

THE SEEDS AND SEEDLINGS OF SOME AMENTIFERAE

(WITH PLATE XXIX)

APPARENTLY few observations have been recorded upon the seedlings of this group. Sir John Lubbock¹ briefly describes seedlings of *Juglans* and *Pterocarya*, and some representatives of the different genera of the Fagaceæ and Betulaceæ. There has been much confusion regarding the seeds of the Juglandaceæ. De Candolle² interpreted the parts of the embryo correctly, as did Kronfeld³ and Lubbock, but most writers on systematic botany have misunderstood them. The seeds and seedlings studied represented the following genera: *Juglans*, *Hicoria*, *Fagus*, *Castanea*, and *Quercus*. Some of the seedlings were grown in moss in the greenhouse and were not subjected to frost action or cracking. Other seedlings of the same species were grown in the garden from seeds planted in the fall. *Juglans nigra* and *J. cinerea* were the only ones that would not grow in the greenhouse. They obviously required the frost action to break their shells.

JUGLANDACEÆ. As is well known, the fruit in this family is a nut, enclosed in a fleshy pericarp, endosperm is absent, and the embryo is straight. The pericarp ruptures into four valves in *Hicoria* and is normally indehiscent in *Juglans*. The wall of the nut is bony and splits into two valves on germinating. The embryo is large and fleshy, two large lobes which appear like cotyledons stand erect on a short hypocotyl. De Candolle⁴ well describes the condition: "The cotyledons are always opposed to the valves of the nut, each of the chambers in the nut contains the halves of two different cotyledons." In *Hicoria*, the cotyledons are two-parted and intricately folded, and a lobe of one cotyledon unites with a lobe of the other by a peculiar

¹ LUBBOCK, SIR JOHN: A contribution to our knowledge of seedlings.

² CANDOLLE, C. DE: Mémoire sur la famille des Juglandées.

³ KRONFELD, M.: Beiträge zur Kenntniss der Walnuss.

⁴ DE CANDOLLE, *op. cit.*

turning over of the edges (*figs. 4-8*). The cotyledons are separated for some distance near the tops of the lobes. In *Juglans* the cotyledons are deeply two-parted (*fig. 1*); the cotyledon in the nut being U-shaped (*fig. 3*) and their lobes united to the summit (*fig. 2*). In *Hicoria* the shape of the embryo varies greatly in the different species. *Hicoria glabra* and *Hicoria microcarpa*, which in this region are not sharply separated, have the embryos much alike, but in *Hicoria glabra* the division between the cotyledons is twice as deep as in *Hicoria microcarpa*.

In germinating, the seed splits from the micropyle and the tip of the radicle and the two or four basal lobes of the cotyledons push out together. The petioles of the cotyledons lengthen and carry the plumule out of the nut. The cotyledons remain in the nut and do not decrease to any appreciable extent in size, but become very rancid in taste and are filled with a yellowish oil similar to that found in the husks of walnuts and butternuts. The valves of the nut usually remain slightly connected at the hilum but often are split entirely apart, and in one specimen of *Juglans cinerea* where the nut was on the surface of the ground, the two valves had separated and lay one on each side of the stem. The cotyledons, where exposed to the light, were green and could be easily drawn from the nut.

The root of the seedling becomes greatly thickened. In one specimen of *Hicoria glabra*, it was 6^{cm} long and 1.3^{cm} in diameter, and others were nearly as large. The outer portion becomes brown and fissured, the fissures extending to the endodermis. In older seedlings the root becomes very long; in large seedlings of *Juglans nigra* and *J. cinerea* it was over one-third the total length of the plant axis and in *Hicoria* about two-thirds. In one specimen of *Hicoria alba*, where the main stem had been killed and its place taken by a branch from the axil of one cotyledon, the young stem was 3^{cm} long and the root 20^{cm} long (*fig. 12*). The hypocotyl does not develop. The petioles of the cotyledons attain a length of 0.5 to 1.5^{cm}. The young stem bears four to eight scales before the first leaves appear. In *Juglans cinerea* these scales were two-ranked and in the same plane as the cotyledons, but in all the others they showed the two-fifths arrangement. As the seedlings naturally germinate under trees where the nuts would be buried under leaves, and as the internodes have not the power to lengthen much, Lubbock⁵ suggests that the first leaves are

⁵ LUBBOCK, SIR J., *op. cit.*

reduced to scales and only those that would be sure of reaching above the covering expand as true leaves. No stipules are produced. The young stem and leaves are glandular pubescent. In a number of seedlings of *Juglans cinerea* examined, the first two to four leaves were of five leaflets, the next two or three of seven, and the next ones of nine. A few had the first leaf above the scales of three leaflets. Often one leaflet of the uppermost pair of leaflets was obsolete. In *Juglans nigra* the first two to four leaves were of five leaflets, the next two or three of seven, the next two of nine, and where others were present they were of eleven leaflets. In *Hicoria* the first leaf was often entire or three-lobed and the next three-lobed or of two leaflets, but usually the first four or five leaves were of three leaflets. In the seedlings in the garden three or four leaves developed and then a terminal bud was formed. About the middle of July many of these buds opened and two or three more leaves developed, which were often of five leaflets. In the seed in *Hicoria* the plumule is made up of ten to twelve leaves. Probably not all of these develop in the first season. In the seedlings of *Hicoria* in the garden the main stem was often killed in some way near the surface of the ground, and the growth of the axis continued by a bud from the axil of the cotyledon or of one of the scales. In the seedling of *Hicoria ovata* figured (*fig. 12*) the main stem and the branch from the axil of one cotyledon had both died and the bud from the axil of the other cotyledon taken its place. Often in this way two, or even three, stems of about equal vigor arise.

FAGACEÆ. In *Fagus* the cotyledons are broader than long, notched at the apex and the two folded together into a triangular form completely filling the nut. This folding varies in different nuts. Basal lobes of the cotyledons surround and nearly cover the radicle. In *Castanea* the cotyledons have two to six basal lobes that nearly cover the radicle and the cotyledons are broadly ovate, thick, and entire. In *Quercus* the cotyledons are oval to orbicular, very thick, and entire, varying in size and shape in the different species. The basal lobes, two to six, completely cover the radicle.

In *Fagus* the shell splits in germinating along the three angles and the root pushes out, then the cotyledons expand and enlarge and split the shell more and throw it off. The hypocotyl lengthens considerably and raises the sessile cotyledons well above the ground. In *Castanea* the cotyledons swell where their petioles join them so as to force the two apart and split the shell. Then the basal lobes push out

and spread apart and the radicle grows out. The petioles of the cotyledons elongate and carry the plumule out. In *Quercus* germination takes place as in *Castanea*.

In the seedling of *Fagus* the root does not become greatly thickened as in the *Juglandaceæ*, but secondary thickening soon occurs. The cotyledons expand and become green but drop off soon after the first leaves expand. The stem and leaves are hairy; the first leaves are of the same form as the mature ones. In *Castanea* the root soon thickens and has longitudinal fissures extending down to the endodermis. The stem bears several scales, two to six, below the leaves, and the first leaves are of the same form as the mature ones and bear deciduous stipules. In *Quercus* the seedlings resemble those of *Castanea*, but there are often more scales on the stem, the uppermost of which bear stipules. The leaves in *Quercus velutina*, *Q. platanooides*, and *Q. macrocarpa* are all serrate and much alike, but the older leaves become more like the mature ones, but are not deeply lobed or cut. The stem and leaves are pubescent.

CONCLUSIONS. The cotyledons in *Juglans* and *Hicoria* correspond with the valves of the nut and are deeply two-lobed. The two divisions of the embryo resembling cotyledons are each made up of halves of the cotyledons.

The seeds of *Hicoria* germinate without frost action; those of *Juglans* only with frost action.

The tap root is very thick in young seedlings, and very long in older ones.

In *Castanea* and *Quercus* the shell is split in germination by a swelling of the cotyledons.

In the species of *Quercus* studied, the leaves of the seedlings were much alike and not deeply cut or lobed.

Fagus is the only one in which the hypocotyl lengthens, or the cotyledons become aerial.—W. W. ROWLEE and GEORGE T. HASTINGS, *Cornell University*.

EXPLANATION OF PLATE XXIX.

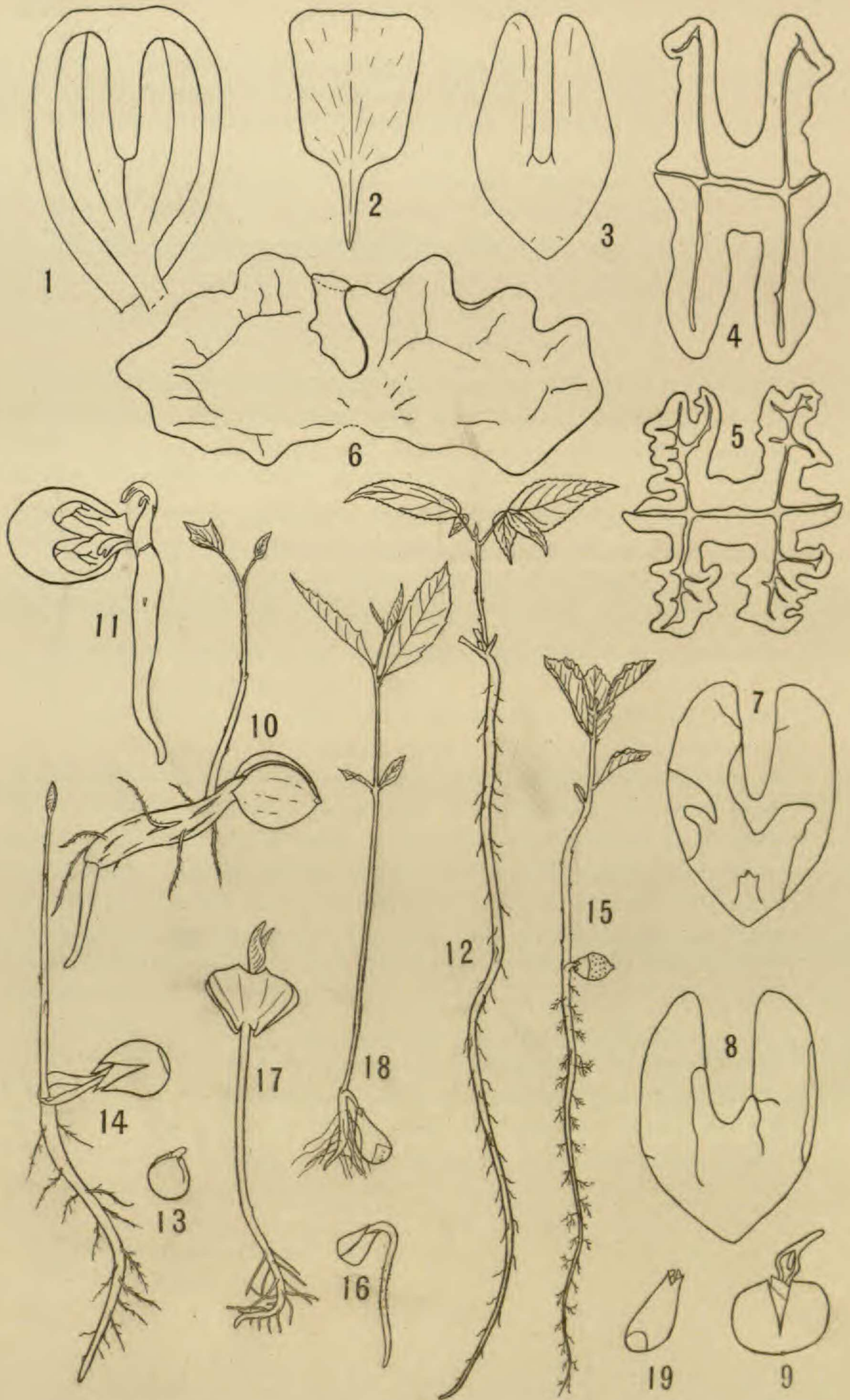
FIGS. 1-3. Cotyledons of *Juglans cinerea*. $\times 2$.

FIG. 4. Cotyledons of *Hicoria laciniosa*. $\times 5$.

FIG. 5. Cotyledons of *Hicoria minima*. $\times 5$.

FIGS. 6-8. Cotyledons of *Hicoria glabra*. $\times 3$.

FIGS. 9, 10. Seedlings of *Hicoria glabra*. Nat. size.



ROWLEE and HASTINGS on AMENTIFERÆ